EV Charging Infrastructure & EV Battery End-of-Life

Georgia Joint Study Committee of Electrification on Transportation

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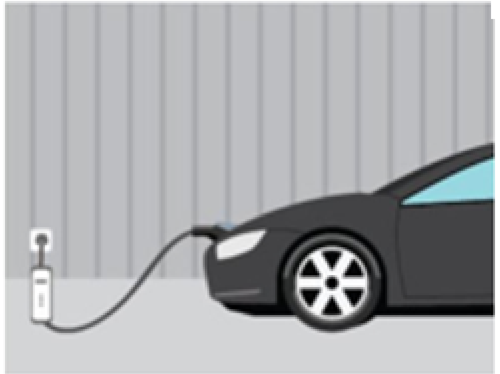
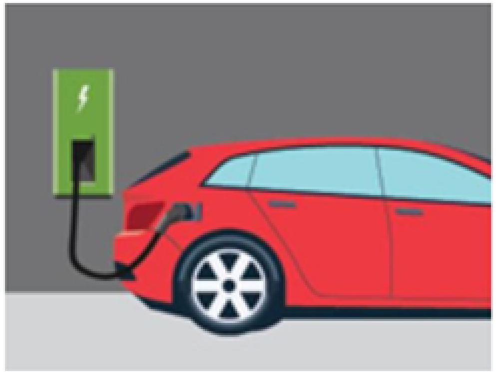
EV Charging Infrastructure

Leveling Up – EV Charging Basics

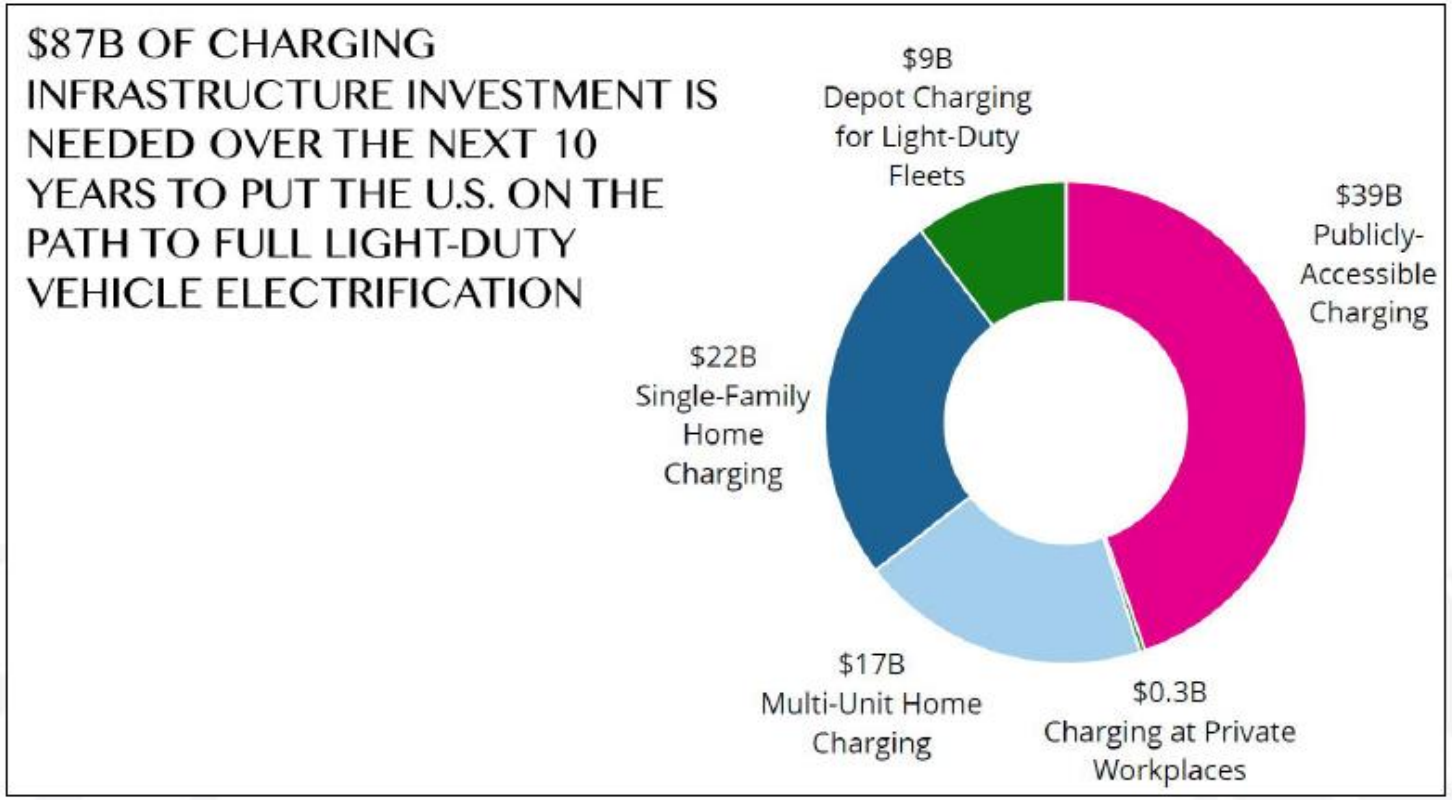
		Range	Application
Level 1		**3 to 6** Miles of range/hour	• Residential PHEV • Airports • Some workplace
Level 2		**20 to 40** Miles of range/hour	• Residential • Workplace • Public • Fleet (overnight)
Level 3 **(Direct Current Fast Charge, DCFC)**		**250 to 500** Miles of range/hour	• Corridor (IIJA) • Transit hub (TNC, Taxi) • City Center Cluster • Fleet

EV Charging Infrastructure Gap

Currently Available	Total Ports		Non-Proprietary	
	Georgia	U.S.	Georgia	U.S.
Level 2	2,858	94,166	2,391	92,725
DC Fast Chargers	718	25,593	331	10,249

To reach 100% EV sales by 2035, **$39B required for publicly-available charging by 2030**

(Analysis assumes all DCFCs are 350kW. If chargers are 150kW, cost increases to $52B)



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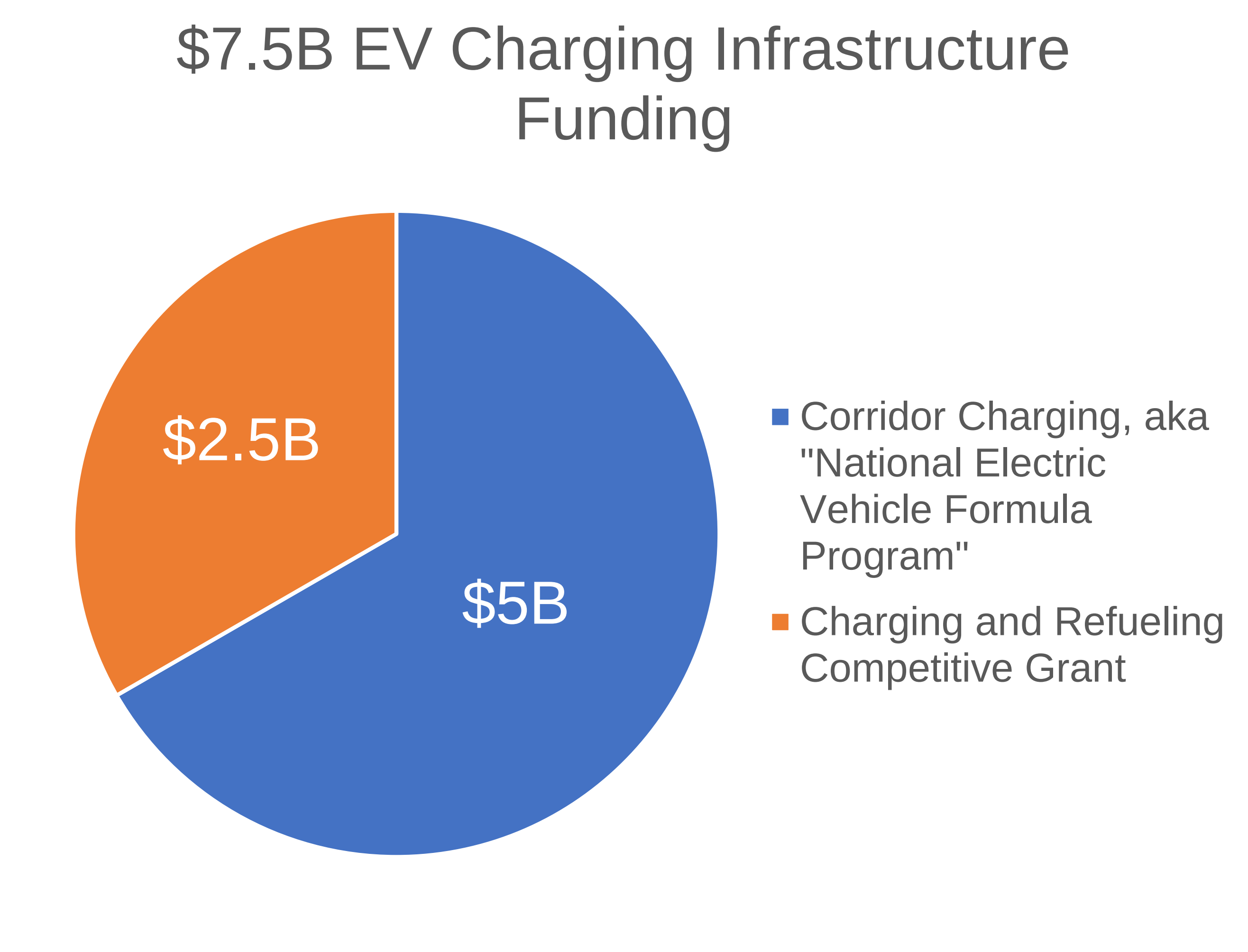
Sources:
EV charging figures as of June 22, 2022: https://afdc.energy.gov/stations/#/analyze?country=US&fuel=ELEC&ev_levels=dc_fast
EV charging infrastructure investment analysis: Atlas Public Policy, *U.S. Passenger Vehicle Electrification Assessment* (April 2021)

Infrastructure Investment & Jobs Act EV Charging Infrastructure



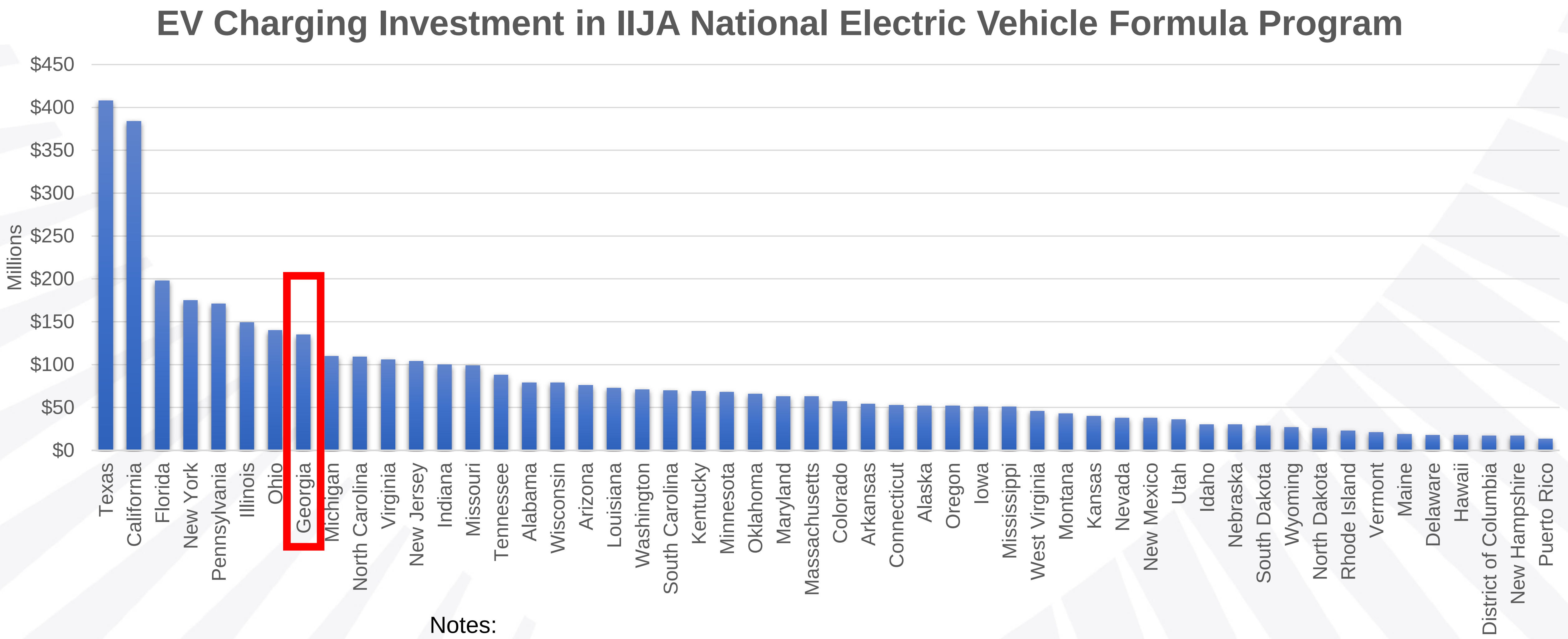
National EV Formula Program

- FY22 – FY26; Federal share = 80%
- Funds allocated to states using formula (23 U.S. Code § 104 subsection (c))
- To be used for EV charging on alternative fuel corridors
  - If alt. fuel corridors fully built out, funding may be used for publicly available chargers
- States must submit plans to DOT on intended funding usage
- DOT and DOE must provide guidance to states to prioritize investments, i.e.:
  - "current and anticipated market demands for [EV] charging infrastructure, including with regard to power levels and charging speed, and minimizing the time to charge current and anticipated vehicles"

Charging and Refueling Infrastructure Grants

- FY22 – FY26; Federal share up to 80%
- Charging *and* hydrogen, propane, and natural gas fueling
- 50% along FHWA-designated Alt. Fuel Corridors & 50% "Community Grants"
- Publicly accessible projects outside of Alt. Fuel Corridors given priority for rural, low income and underserved communities, and multi-unit dwellings

State EV Charging Funding through National Electric Vehicle Formula Program



Notes:
- Values rounded to the nearest $million.
- Does not take into account $2.5B for competitive grants.
- Source - [White House Fact Sheets]

NEVI EV Charging Minimum Standards NPRM

	NEVI NPRM	Auto Innovators Recommendations
Minimum Power Level	150 kW	350 kW
Station Type	DCFC	DCFC
Connector Type	SAE CCS	SAE CCS
Distance Between Chargers	50 miles	50 miles (as a starting point)
Ports/Station	4	Multiple
Communication	Outages, malfunctions, pricing, etc. in real time via Open Charge Point Interface (OPCI) 2.2	Must be able to communicate to drivers charging station status
Charger-to-Network Communication	Open Charge Point Protocol (OCPP)	OCPP
Accessibility	24/7	24/7
Payment Methods	All major debit/credit cards, not restricted by membership or payment type. Plug and Charge payment capabilities is required	Credit cards via credit card reader at a minimum
Pricing	$/kWh	$/kWh
Uptime	97%	Required, but not specified
Station Configuration	No requirement, but encourage states to take into account larger vehicles and vehicles with trailers	Consider different vehicle configurations and vehicles with trailers
EV Charging Signage	Not included due to open proceeding on updating the Manual on Uniform Traffic Control Devices	Allow signage on highway service signs

EV Charging Infrastructure Summary

- Significant gap in pending funding and charging needs to support electrification goals
  - Additional public and private investment is necessary
- $39B to $52B investment estimated needed nationally in publicly-available charging by 2030
  - Investment range depends on power level of DC Fast Chargers (350 kW versus 150 kW)
- $7.5 billion in Infrastructure Investment & Jobs Act is a good down payment
  - Begins to address corridor charging, but charging at other locations is still needed

EV Battery End-of-Life

Opportunities for Used EV Batteries

Reuse: refurbishing battery modules or packs to as good or better quality and performance levels through the replacement of worn or deteriorated components and re-certifying them to OEM specifications.

Repurpose: refurbishing EV battery components or packs to fulfill a different use from what was originally intended.

Recycle: treating EV batteries to recover the maximum amount of raw materials for reuse in identical or alternative industries.

EV Batteries - Circular Economy Growth – North America

Time Frame	Near Term (~2020-2025)	Medium Term (~2026-2030)	Long Term (beyond 2030)
EV Battery Manufacturing in US	• First cell plants (beyond Gigafactory) open • Scrap from cell plants will promote more recycling facilities	• >10 EV battery cell plants • Direct positive-value recycling facilities increasing	• >20 EV battery cell plants • Potential for direct recycling/cathode and anode recovery
EV Battery Supply Chain Development	• First domestic CAM & precursor plants • Input material supply chain tied only to mining operations • Recycled material validation	• Refining/processing comes on-line • First mines/extractions • Supply chain hooking up with recyclers • Recycled material use begins	• Mature domestic supply chain, including recycling with appropriate standards like plastics industry • Recycled material is a significant portion of battery material
EV Battery Re-use Technology/Market	• “R&D” phase	• “Start-up” phase	• “Mature” phase
Large Format Li-Ion Recycling Volume	• Most batteries refurbished (few entire batteries are scrapped) • Low quantities of batteries processed through pyro processes	• Some batteries/vehicles reach EOL • Positive-value recycling scaling up	• Closer to “steady state” of used EV battery flow
kWh of vehicle Li-ion batteries recycled / year	• LOW	• LOW and growing	• MEDIUM and growing
Battery Recycling	• Positive-value recycling emerging	• Positive-value recycling technology and logistics growth	Cathode manufacturing uses a high percentage of recycled material like copper industry

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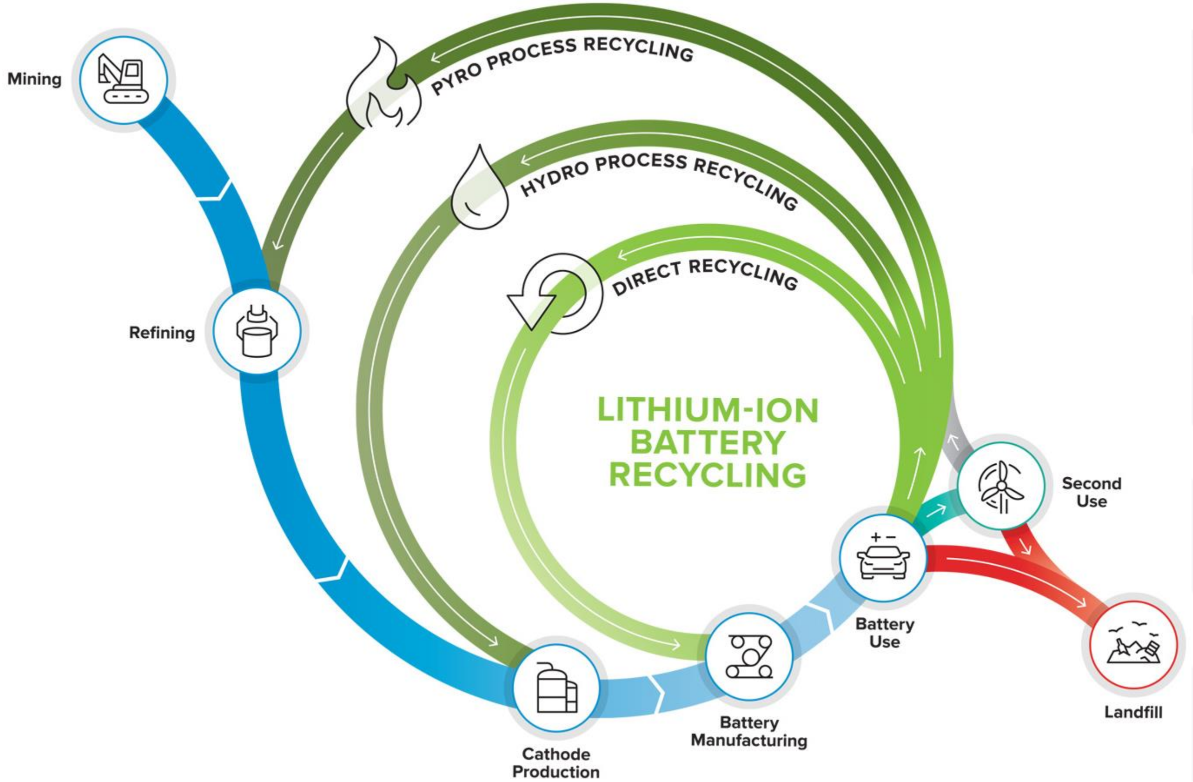
Li-Ion Battery Recycling Opportunity

Domestic battery recycling can:

- Provide national energy security
- Reduce our dependency on foreign nations for materials
- Create domestic jobs
- Lower EV battery costs
- Stabilize critical mineral supply chain
- Enhance lifecycle environmental footprint



https://recellcenter.org/research/

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Non-Vehicle Secondary Use Batteries

Retired EV batteries retain significant capacity

Batteries can support national energy security for use as a distributed energy resource, microgrid, utility buffering, renewable energy storage, etc.

BMW Battery Storage Farm, https://cleantechnica.com/2017/10/30/bmw-group-officially-commissions-battery-storage-farm-leipzig/

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EV Battery End-of-Life Summary

- EV battery recycling offers strategic and economic opportunity for U.S.
- Secondary use batteries can provide positive impact to national energy security and trade policy
- EV battery policy should be flexible and not hinder EV battery innovation
- Resilient domestic policy will bolster U.S. jobs, energy security, and leadership in electrified future

Auto Innovators Resources

- Auto Innovators [Get Connected EV Quarterly Report]
  - State-by-state and National status of EV sales, charging stations, EV price, etc.

- Auto Innovators [Recommended Attributes for Charging Stations] (Dec. 2021)
  - 350kW DCFC on corridors and transit hubs, SAE J1772 and SAE CCS connectors, credit card payment, 24/7 access, networked, standardized $/kWh pricing, etc.

- Auto Innovators [EV Charging Infrastructure Guiding Principles] (Sept. 2021)
  - No-compromise mobility, need for public-private partnerships, utility rates and programs, grid upgrades, benefit to all customers, and building code requirements

- Auto Innovators [EV Battery Recycling Policy Framework]
  - EV battery recycling policy framework to ensure as close to 100% of end-of-life EV batteries are properly recycled or reused

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Transforming Personal Mobility

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